What is claimed is:

1. A method of etching a substrate, the method comprising:

(a) placing a substrate in a process zone, the substrate comprising a material having a thickness;

(b) introducing an etchant gas into the process zone;

(c) energizing the etchant gas to etch the material; and

(d) determining an endpoint of etching the material by

(i) reflecting a light beam from the substrate, the light beam having a wavelength selected to have a coherence length in the substrate of from about 1.5 to about 4 times the thickness of the material, and

(ii) detecting the reflected light beam to determine an endpoint of the substrate etching process.

2. A method according to claim 1 further comprising selecting the wavelength to have a coherence length in the substrate of from about 2 to about 3 times the thickness of the material.

3. A method according to claim 1 comprising selecting the wavelength according to the approximate proportionality: coherence length $\alpha\ \lambda^2/\Delta\lambda$, where λ is the wavelength and $\Delta\lambda$ is the bandwidth of wavelengths in the light beam.

4. A method according to claim 1 wherein the material comprises exposed regions between features of a patterned mask, and further comprising selecting the wavelength to maximize an absorption differential that is a difference between the absorption of the light beam in the patterned mask and the absorption of the light beam in the material.

5. A method according to claim 1 comprising selecting the wavelength to be less than about 240 nm.

6. A method according to claim 5 comprising selecting the wavelength to be from about 150 to about 220 nm.

7. A method of etching a substrate, the method comprising:

(a) placing a substrate in a process zone, the substrate comprising a material with exposed regions between features of a patterned mask;

(b) introducing an etchant gas into the process zone;

(c) energizing the etchant gas to etch the material; and

(d) determining an endpoint of etching the material by

(i) reflecting a light beam from the substrate, the light beam having a wavelength selected to maximize an absorption differential that is a difference between the absorption of the light beam in the patterned mask and the absorption of the light beam in the material, and

(ii) detecting the reflected light beam to determine an endpoint of the substrate etching process.

8. A method according to claim 7 wherein the patterned mask has an absorption coefficient and a thickness, and comprising selecting the wavelength according to the absorption coefficient and thickness of the mask to maximize the absorption differential.

9. A method according to claim 7 comprising selecting the wavelength to be less than about 240 nm.

10. A method according to claim 9 comprising selecting the wavelength to be from about 150 to about 220 nm.

11. A method according to claim 7 further comprising selecting the wavelength to have a coherence length in the substrate of from about 1.5 to about 4 times a thickness of the material.

12. An apparatus for etching a substrate, the apparatus comprising:

a chamber comprising a substrate support to hold a substrate, the substrate comprising a material having a thickness;

a gas distributor to introduce an etchant gas into the chamber;

a gas energizer to energize the etchant gas to etch the material of the substrate;

a light beam source to reflect a light beam from the substrate, the light beam having a wavelength selected to have a coherence length in the substrate of from about 1.5 to about 4 times the thickness of the material;

a light detector to detect the reflected light beam and generate a signal in response to a measured intensity of the reflected light beam; and

a controller to evaluate the signal to determine an endpoint of the substrate etching process.

13. An apparatus according to claim 12 wherein the light beam source is adapted to direct a light beam having a wavelength selected to have a coherence length of from about 2 to about 3 times the thickness of the material.

14. An apparatus according to claim 12 wherein the light beam source is adapted to direct a light beam having a wavelength selected according to the approximate proportionality: coherence length $\alpha\ \lambda^2/\Delta\lambda$, where λ is the wavelength and $\Delta\lambda$ is the bandwidth of wavelengths in the light beam.

15. An apparatus according to claim 12 wherein the light beam source is adapted to direct a light beam having a wavelength of less than about 240 nm.

16. An apparatus according to claim 15 wherein the light beam source is adapted to direct a light beam having a wavelength of from about 150 to about 220 nm.

17. An apparatus according to claim 12 wherein the material comprises exposed regions between features of a patterned mask, and wherein the light beam source is adapted to direct a light beam having a wavelength selected to maximize an absorption differential that is a difference between the absorption of the light beam in the patterned mask and the absorption of the light beam in the material.

18. An apparatus for etching a substrate, the apparatus comprising:

a chamber comprising a substrate support to hold a substrate, the substrate comprising a material with exposed regions between features of a patterned mask;

a gas distributor to introduce an etchant gas into the chamber;

a gas energizer to energize the etchant gas to etch the material;

a light beam source to reflect a light beam from the substrate, the light beam having a wavelength selected to maximize an absorption differential that is a difference between the absorption of the light beam in the patterned mask and the absorption of the light beam in the material;

a light detector to detect the reflected light beam and generate a signal in response to a measured intensity of the reflected light beam; and

a controller to evaluate the signal to determine an endpoint of the substrate etching process.

19. An apparatus according to claim 18 wherein the mask has an absorption coefficient, and wherein the light beam source is adapted to direct a light beam having a wavelength selected according to the absorption coefficient to maximize the absorption differential between the light beam in the mask and in the material below the mask.

20. An apparatus according to claim 18 wherein the light beam source is adapted to direct a light beam having a wavelength of less than about 240 nm.

21. An apparatus according to claim 20 wherein the light beam source is adapted to direct a light beam having a wavelength of from about 150 to about 220 nm.

22. An apparatus according to claim 18 wherein the light beam source is adapted to direct a light beam having a wavelength selected to have a coherence length in the substrate of from about 1.5 to about 4 times the thickness of the material below the mask.